CLAIMS

What is claimed is:

1. A vessel comprising:

a vessel body having at least one surface which is curved about both a vessel body axis and a second axis; and

a reinforcing structure comprising a plurality of gore pieces, each gore piece comprising a sheet of composite material including a first surface, a second opposing surface and a plurality of fibers extending substantially parallel to the first surface, each gore piece exhibiting a first width at a first longitudinal location along a length of each gore piece and a second lesser width at a second longitudinal location along the length of each gore piece, wherein the first longitudinal location of each gore piece is disposed at a first radial distance from the vessel body axis, the second longitudinal location of each gore piece is disposed at a second lesser distance from the vessel body axis, and wherein at least a portion of the first surface of each gore piece is disposed over and conforms to at least a portion of the at least one surface of the vessel body.

2. The vessel as set forth in claim 1, wherein each gore piece comprises a preimpregnated fiber reinforced composite material.

3. The vessel as set forth in claim 1, wherein each gore piece comprises a bonding material to bond the gore pieces to one another.

4. The vessel as set forth in claim 3, wherein the bonding material comprises a resin.

5. The vessel as set forth in claim 1, wherein the plurality of fibers of each gore piece is oriented in a plus/minus configuration relative to a longitudinal axis along the length of the respective gore piece.

6. The vessel as set forth in claim 5, wherein the plurality of fibers in the plus/minus configuration of each gore piece is oriented at a fiber angle of between about 30° and 60° with respect to the longitudinal axis of the respective gore piece.

7. The vessel as set forth in claim 6, wherein the fiber angle is about 45°.

8. The vessel as set forth in claim 1, wherein each gore piece has a shape that comprises a substantially triangular section.

9. The vessel as set forth in claim 5, wherein at least some of the plurality of fibers are configured to effectively intersect one another and define a space configured substantially as a rhombic section.

10. A vessel as set forth in claim 1, wherein:
the gore body comprises a first layer of gore pieces disposed around the doubly curved surface, and sequential ones of the first layer gore pieces overlap on another.

11. A vessel as recited in claim 1, wherein each of the first layer gore pieces overlaps an adjacent firth layer gore piece by about 40 to 60 percent.

12. A vessel as recited in claim 1, wherein the gore body has a substantially uniform thickness.

13. The vessel as recited in claim 1, wherein the reinforcing structure has a substantially uniform thickness.

14. The vessel as recited in claim 1, wherein a longitudinal axis along the length of each gore piece is offset with respect to the vessel body axis at an angle of between about +15° and -15°.

15. The vessel as set forth in claim 1, wherein a longitudinal axis along the length of each gore piece is offset with respect to the vessel body axis at an angle of about 20° or less.

16. A reinforcing structure for a vessel having a vessel body with at least one surface which is curved about both a vessel body axis and a second axis, the reinforcing structure comprising:

a plurality of gore pieces, each gore piece of the plurality comprising a sheet of composite material including a first surface, a second opposing surface and a plurality of fibers extending substantially parallel to the first surface, each gore piece exhibiting a first width at a first longitudinal location along a length of each gore piece and a second lesser width at a second longitudinal location along the length of each gore piece, wherein the first longitudinal location of each gore piece is configured to be disposed at a first radial distance from the vessel body axis and wherein the second longitudinal location of each gore piece is configured to be disposed at a second lesser radial distance from the vessel body axis, and wherein at least a portion of the first surface of each gore piece is disposed over and conforms to at least a portion of the at least one surface of the vessel body.

17. The reinforcing structure as set forth in claim 16, wherein each gore piece comprises a preimpregnated fiber composite material.

18. The reinforcing structure as set forth in claim 16, wherein each gore piece comprises a bonding material to bond the gore pieces to one another.

19. The reinforcing structure as set forth in claim 18, wherein the bonding material comprises a resin.

20. The reinforcing structure as set forth in claim 16, wherein the plurality of fibers of each gore piece is oriented in a plus/minus configuration relative to a longitudinal axis along the length of each gore piece.

21. The reinforcing structure as set forth in claim 20, wherein the plurality of fibers in the plus/minus configuration of each gore piece is oriented at a fiber angle of between about 30° and 60° with respect to the longitudinal axis of each gore piece.

22. The reinforcing structure as set forth in claim 21, wherein the fiber angle is about 45°.

23. The reinforcing structure as set forth in claim 20, wherein at least some of the plurality of fibers are configured to effectively intersect one another and define a space configured substantially as a rhombic section.

24. The reinforcing structure as set forth in claim 16, wherein each of the gore pieces has a shape that comprises a substantially triangular section.

25. A method for making a reinforcing structure for a vessel having a vessel body with at least one surface which curves about both a vessel body axis and a second axis, the method comprising:

forming a plurality of gore pieces for disposition on the at least one surface of the vessel body including forming each of the plurality of gore pieces as a sheet of composite material having a first surface, a second opposing surface and a plurality of fibers extending substantially parallel to the first surface;

defining each gore piece to exhibit a length, a first width at a first longitudinal location along a length of each gore piece and a second lesser width at a second longitudinal location along the length of each gore piece;

disposing at least a portion of the first surface of each gore piece on at least a portion of the at least one surface of the vessel body such that the first longitudinal location of each gore piece is disposed at a first distance from the vessel body axis and the second longitudinal location of each gore piece is disposed at a second lesser distance from the vessel body axis; and

conforming the at least a portion of the first surface of each gore piece to the at least a portion of the at least one surface of the vessel body.

26. The method as set forth in claim 25, further including orienting the plurality of fibers in a plus/minus configuration relative to a longitudinal axis along the length of each of the gore pieces at a fiber angle of between about 30° and 60°.

27. The method as set forth in claim 26, further comprising orienting the plurality of fibers at a fiber angle of about 45°.

28. The method as set forth in claim 25, further including configuring each of the gore pieces as a substantially triangular section.

29. The method as set forth in claim 25, further comprising orienting at least some of the plurality of fibers of each gore piece to effectively intersect and define a space configured substantially as a rhombic section.

30. The method as set forth in claim 25, further including disposing a bonding material on each of the gore pieces.

31. The method as set forth in claim 30, wherein disposing a bonding material on each of the gore pieces further comprises disposing a resin on each of the gore pieces.

32. A method for reinforcing a vessel having a vessel body with at least one surface which is curved about both a vessel body and a second axis, the method comprising:

providing a plurality of gore pieces, each gore piece comprising a sheet of composite material having a first surface, a second opposing surface and a plurality of fibers extending substantially parallel to the first surface, each gore piece exhibiting a first width at a first longitudinal location along a length of each gore piece and a second lesser width at a second longitudinal location along the length of each gore piece;

forming a gore body including disposing the plurality of gore pieces on the vessel body at the at least one surface of the vessel body such that the first longitudinal location of each gore piece is disposed at a first distance from the vessel body axis and the second longitudinal location of each gore piece is disposed at a lesser second distance from the vessel body axis and such that at least a portion of the first surface of each gore piece is configured to be disposed upon and conform to at least a portion of the at least one surface of the vessel body; and

overlapping a portion of at least one of the plurality of gore pieces with a portion of at least one other of the plurality of gore pieces.

33. The method as set forth in claim 32, further comprising bonding the plurality of gore pieces to one another.

34. The method as set forth in claim 33, wherein bonding the plurality of gore pieces to one another further comprises at least partially curing a resin disposed on each of the plurality of gore pieces.

35. The method as set forth in claim 32, further comprising orienting the plurality of fibers in each gore piece in a plus/minus configuration relative to a longitudinal axis along the length of each gore piece.

36. The method as set forth in claim 35, further comprising orienting the plurality of fibers in the plus/minus configuration of each of the gore pieces at a fiber angle of between about 30° and 60° with respect to the longitudinal axis of each gore piece.

37. The method as set forth in claim 36, further comprising orienting the plurality of fibers in the plus/minus configuration of each gore piece at a fiber angle of about 45°.

38. The method as set forth in claim 32, further comprising shaping each gore piece as a substantially triangular section.

39. The method as set forth in claim 32, further comprising orienting at least some of the plurality of fibers of each gore piece to effectively intersect and define a space configured substantially as a rhombic section.

40. The method as set forth in claim 32, wherein the gore piece disposing step includes disposing a first layer of the gore pieces around the doubly curved surface, and overlapping adjacent ones of the first layer gore pieces on one another.

41. The method as recited in claim 32, wherein the overlapping step includes overlapping each of the first layer gore pieces over an adjacent one of the first layer gore pieces by about 40 to 60 percent.

42. The method as recited in claim 41, wherein the overlapping step includes overlapping each of the first layer gore pieces over an adjacent one of the first layer gore pieces by about 50 percent.

43. The method as recited in claim 32, wherein forming a gore body includes configuring the gore body to exhibit a substantially uniform thickness.